Transverse stability limits:
At present we are most troubled by single bunch transverse instabilities near transition.
The transverse impedance model is low by a factor ~ 3. (SYZ epac02, MMB pac03).
So, scale from the most extreme conditions of the last run to obtain threshold estimates.
For a transverse wake potential with a time scale much less than the bunch length, the rigid mode betatron tune shift is.

$$\Delta Q = K_0 \frac{Z I_p}{A \gamma},$$

where K_0 is a constant that is independent of species, energy and bunch length; Z is the atomic number; I_p is the peak current; A is the atomic weight; and γ is the Lorentz factor.
The fast head tail instability (TMCI) threshold occurs for (Chao 93),

$$\Delta Q \approx Q_s / \pi$$

For transverse microwave instability the threshold is

$$\Delta Q = K_1 \frac{\Delta p}{p} \left| \xi + n\eta \right|,$$

where $K_1 = O(1)$, ξ is un-normalized chromaticity, η is the frequency slip factor, and $n = f_{carrier}/f_{rev}$.
The rms tune shift due to betatron amplitude from octupoles was $\lesssim 1. \times 10^{-3}$
The 2nd order sextupole contribution has not been estimated.
These values were not "tuned" and we could probably do better.

Near transition $f_{rev}Q_s = f_s \approx 14$ Hz and $\Delta p/p \pm 1.3 \times 10^{-3}$.
Take $h = 2520$, $V_{rf} = 2.5$ MV, and $\ell = 4\sigma_z = 1$ m.

For protons $\gamma = 250$, $f_s = 218$ Hz, $\Delta p/p \pm 1.0 \times 10^{-3}$
For protons $\gamma = 25$, $f_s = 245$ Hz, $\Delta p/p \pm 9.5 \times 10^{-3}$
For Au with $\gamma = 107$, $f_s = 207$ Hz, $\Delta p/p \pm 1.0 \times 10^{-3}$.

For instabilities near transition we had $|\xi| \approx 1$ and small η, so it should be possible to obtain the same (or better) microwave threshold during a store.
The TMCI threshold is much better for the store conditions.
So, if we limit the rigid mode tune shift to the same values obtained during the 2003 deuteron run we should be safe.
Scaling to protons at $\gamma = 250$ the maximum number of protons is 2.8×10^{11}
Scaling to protons at $\gamma = 25$ the maximum number of protons is 2.8×10^{10}
Scaling to Au at $\gamma = 107$ the maximum number of ions is 3.8×10^{9}

For high energy protons and Au the design is safe.
For protons at $\gamma = 25$, the threshold is about 28% of the design number.
Machine studies with 6 bunches and maximum charge per bunch would be useful.

The only longitudinal problems we encountered were associated with solitons and beam loading.
The solitons will be much suppressed in the storage cavity system and could be dissolved via electron cooling.
Beam loading is a serious issue.
The present RF cavities and amplifiers can hold no more than
220 bunches, with 1×10^{11} charges/bunch
It is not certain that this is achievable.